RADIATED SUSCEPTIBILITY SYSTEM VERIFICATION

Practice:

Verify that a flight vehicle or system is hardened to the launch, boost, and flight electromagnetic radiation environment by radiating simultaneously, during system checkout, on all major emission frequencies that are known to exist during vehicle operations. Monitor all critical systems for erroneous performance while the spacecraft or system is stepped through all operating modes.

Benefit:

Spurious interferences and responses can be identified during system checkout. After the spurious responses are evaluated, solutions can be proposed, and remedial action taken, if necessary, prior to the actual flight.

Programs That Certified Usage:

Voyager, Magellan, Galileo, and Ocean Topographic Experiment (TOPEX/POSEIDON)

Center to Contact for Information:

Jet Propulsion Laboratory (JPL)

Implementation Method:

A system verification susceptibility test is planned as part of the system checkout. The susceptibility of all systems to the specified electromagnetic radiation environment is observed while each subsystem is stepped through a typical sequence of operations.

The electromagnetic radiation environment is simulated by operating a number of separate signal generators/amplifiers connected to a cluster of antennas. As the system test progresses, the antenna cluster is directed sequentially at each subsystem from a distance of one meter or other prescribed distance which will provide adequate coverage. Figure 1 shows the physical arrangement for system test of the Galileo spacecraft; seven antennas are directed toward the Energetic Particle Detector (EPD). The antenna assembly was moved to appropriate locations to illuminate each sensitive area as the test progressed.

When a spurious response is observed, each transmitter is turned off and on sequentially until the cause of the response is isolated to one or a combination of radiators. The probability of the particular signal or combination of emitted signals occurring simultaneously with the particular spacecraft mode must be evaluated before any remedial action is initiated.

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Technical Rationale:

In a complex system which emits and is exposed to a number of radiated signals, there is a large number of spurious frequencies which may produce unexpected results during ground checkout, launch, and flight. Sources of electromagnetic radiation are listed in Table 1.

These signals or their harmonics may combine to produce intermodulation products at a sensitive frequency which could cause an unwanted response. Susceptible frequencies that may respond to the emissions are receiver main tuning frequencies, image frequencies, and the 1st and 2nd receiver intermediate frequencies.

Table 1. SOURCES OF RADIATED EMISSIONS

EXTERNAL	INTERNAL
Test Range Tracking Radars	On-board Transmitters
Space Shuttle Transmitters	Receiver Local Oscillators
Booster Transmitters	Clock Oscillators
AM, FM, & TV Broadcast Transmitters	Data Bus Clock Frequencies
Cellular & Mobile Telephones	

By simulating the radiation environment that the vehicle will be exposed to during system checkout and free flight, potential sources of interference can be identified, evaluated, and corrected, if necessary. Synergistic combinations of sources may be detected with this approach. The probability of a successful flight will be increased by performing this verification test.

Impact of Non-Practice:

Erratic or uncontrolled performance may occur which could compromise or abort the mission.

References:

1. "INTERMOD", A computer program to calculate intermodulation products of multiple transmitters that fall within the bandwidths of multiple receivers, Paul Rusales, Lockheed California Co., January 1987.